

The atmosphere above Antarctica

Ancient samples, modern actions

The cold, isolated atmosphere of Antarctica is unusual in one other way, namely that ancient samples of it exist within bubbles trapped in the continent's icy mass. These bubbles, recovered by ice-coring, have been invaluable in showing how Earth's atmosphere changes over time and the consequences of this on the world's climate.

Ozone

Oxygen in the atmosphere is most commonly found in pairs, as the oxygen molecule (O_2), however much rarer ozone molecules exist which are composed of three oxygen (O_3) travelling together. The extra oxygen in an ozone molecule gives it the ability to absorb several different types of radiation from the sun - amongst which, and very important for living organisms, is the ability to absorb harmful ultra violet light. There are several types of ultra-violet light, but the most damaging to reach Earth's surface is UV-B (wavelength < 315 nm) which damages the chromosomes within cells.

This UV protection of life on Earth is achieved even though there is very little ozone in the atmosphere, with most being concentrated high in the atmosphere in the 'ozone layer' - yet even in this layer there are still only about six ozones in every million molecules.

During the late 1970's and early 1980's research by British scientists into the atmosphere above Antarctica, discovered that man-made chemicals (e.g. CFC's) were destroying this protective ozone layer. This alarming discovery resulted in rapid changes in the manufacture and use of the offending chemicals, through the 1987 Montreal Protocol. The resulting prompt shift, from the use of destructive to more 'environmentally friendly' chemicals, was only possible through a willingness to communicate between scientists, the public and politicians of many countries.

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Halocarbons and CFC's

Halogens are group of chemicals which include common elements such as fluorine (F), chlorine (Cl), bromine (Br), and iodine (I).

Halocarbons are molecules containing halogens and carbons. The first man made halocarbons were developed in the 1890s, and used widely in industry from 1930 on. The most troublesome halocarbons for ozone are the chlorofluorocarbons (CFCs), which as the name suggests contain chlorine and/or fluorine .

In the past CFC's were especially useful because they are non-flammable, non-reactive, non-toxic, odourless, and have a low boiling point. This made them really useful in refrigerators and air conditioners, as well as propellants in fire extinguishers and aerosols. Unfortunately these very properties mean CFC's travel easily to the stratosphere above Antarctic, where they busily destroy ozone, over long periods of time.

Adapted from material by Rhian Salmon, Victoria University (NZ) by Donald Reid, iMatters.co.nz in association with Gateway Antarctica, University of Canterbury. Curricula: Science L4 - 8. Images: PiccoloNamek, Meu. Wikicommons.



The formation of the ozone hole.

The breakdown of ozone by CFC's is made even worse by the unique conditions which occur above Antarctica, namely:

- **The Antarctic Vortex.** This strong 'jet stream' wind isolates Antarctica's stratosphere from the rest of the planet. It forms during the polar night and keeps ozone destroying chemicals above Antarctica.
- **Polar Stratospheric Clouds.** These form in the polar stratosphere, high above normal weather clouds. They are a mixture of ice, nitric acid and sulfuric acid crystals and their chemistry ensures chlorine remains available to breakdown ozone.
- **Cold and light.** The intense cold of spring means some unusual chemical reactions occur, including some that are triggered by the returning sunlight.

These three factors combine to make a chemical and physical cocktail so effective that within a few spring weeks, all of the ozone layer above Antarctica is destroyed. Yet as the Antarctic summer approaches the atmosphere warms, mixes and replenishes itself with ozone from the north. Come winter the Antarctic vortex reforms and the atmosphere is primed and ready again, for rapid ozone breakdown in spring.

Task: Aerosols

Introduction

Our manufacture and use of ozone damaging chemicals prior to 1987, means it will be at least 2070 before we can expect the atmosphere above Antarctica to have a 'normal' levels of ozone again.



What to do

1. List 10 aerosols found in the home, workshop or garage.
2. Use the label to name the propellant used in each.
3. Tick those that are 'environmentally friendly'.

How it works

Propellants provide the pressure within aerosols.

Hydrocarbons are less harmful than Halocarbons and CFCs.

Relevance

We should know the effects of the products we use.

Man-made chemicals can alter the complex natural reactions that occur above Antarctica, something which has consequences for the whole planet.

For a full range of Antarctic and Southern Ocean resources visit:
The Antarctic Hub www.antarctichub.org